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The Wilson Journal of Ornithology 119(3):479–483, 2007

Locality Related Changes in the Diet of the Barn Owl (*Tyto alba stertens*) in Agroecosystems in Central Punjab, Pakistan

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ABSTRACT.—We studied spatial differences in Barn Owl (*Tyto alba stertens*) diets in agroecosystems of six districts of central Punjab, Pakistan. Analysis of pellets collected over 3 years revealed the house shrew (*Suncus murinus*) dominated all diets. This species constituted 75.0% of the diet in the Sheikhpura District, 68.4% in the Okara District, 67.2% in the Faisalabad District, 65.6% in the Toba Tek Singh District, 59.3% in the Jhang District, and 56.3% in the Hafizabad District. Rats and mice together formed 28% of the overall diet while birds (4.2%) were consumed more than bats (2.0%). The greatest diversity in Barn Owl diets was in the Jhang District. Received 21 July 2006. Accepted 19 November 2006.

Mason and Lefroy (1912), Ali and Ripley (1969), and Roberts (1991) have been the main sources of information on Barn Owls in southern Asia. More recently, Mahmood-ul-Hassan et al. (2000) presented information on the food habits of the Barn Owl in central Punjab, Pakistan.

Our objectives were to: (1) investigate the food habits of the Barn Owl in the six districts of central Punjab, and (2) compare locality-related diversity in diets.

METHODS

We collected 1,163 pellets of Barn Owls from 11 sites in Faisalabad District (31° 25' N, 73° 07' E), 394 from 4 sites in Jhang District (31° 16' N, 72° 19' E), 342 from 4 sites in Hafizabad District (32° 04' N, 73° 41' E) and 388 from 2 sites in Sheikhpura District (31° 42' N, 73° 30' E). We also had small samples of Barn Owl pellets collected from single sites in Toba Tek Singh ($n = 37$) (30° 57' N, 72° 28' E) and Okara ($n = 36$) (30° 48' N, 73° 27' E) districts. These sites were visited once every month during 3 years. Pellets were initially placed in polythene bags along with tags indicating date and locality of collection. Pellets were stored over night at 55° C before then being stored in paper bags. Each pellet was then analyzed to identify remnants of Barn Owl prey. We counted mammalian skulls to ascertain the number of prey items present in each pellet. If skulls were absent, pairs of mandibles or numbers of atlas vertebrae were counted. We identified mammalian prey to

The Barn Owl (*Tyto alba*) is universally acknowledged for its use of rodents and other small mammals as food. Thus, this species is thought to have an important role in control of potential agricultural pests (Duckett 1991, Mohammad and Goh 1991, Lee 1997, Lekunze et al. 2001). The diet of the Barn Owl in most parts of the world is well documented but information on this species in Asia and particularly southern Asia is generally poor.

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species level from skulls and teeth using reference skulls of small mammals known to be present in the study area (Mahmood-ul-Hasan et al. 2000).

The data obtained were used to assess the locality-related diversity of the prey fauna represented in the Barn Owl pellets. We used three indices: (1) species richness (S), (2) Shannon's index (H'), and (3) Peilou's evenness (E) to assess and compare the diversity (Magurran 1988) in the diet of Barn Owls.

RESULTS

Diet Composition.—Shrews and rodents were the main staples of the diet of Barn Owls in the six districts of Punjab (Table 1). Shrews (65.6%) were taken more frequently than rodents (27.8%). The soft-furred field rat (*Rattus meltdada*) and the bandicoot rat (*Bandicota bengalensis*) were the rodents most often taken. Soft-furred field rats were consumed most by owls in the Toba Tek Singh District and least by owls in the Okara District whereas bandicoot rats were consumed most often in the Okara (10.5%) and Hafizabad (9.4%) districts, and least in the Sheikhupura (5.4%) District. The proportions of these rats in the remaining districts ranged from 3.8 to 7.3% and 5.4 to 7.4%, respectively. The averages for these two species in the six districts were 6.2% and 6.5% (Table 1).

The house rat (*Rattus rattus*) was consumed more in Hafizabad (4.4%) and Faisalabad (4.2%) districts than in the other four districts; its proportion in the diet of Barn Owls in the six districts ranged from 1.6 to 4.4% with an average of 3.5%. The house mouse (*Mus musculus*) comprised from 1.3 to 4.3% (mean = 2.5%) in the diets of the owls in the six districts. The proportion of the little Indian field mouse (*M. booduga*), which was not recorded in the Hafizabad sample, varied from 1.4 to 4.8%; the average for the six districts was 2.5%. The short-tailed mole rat (*Nesokia indica*) was represented in samples of pellets in all six districts; its proportions ranged from 1.2% (Hafizabad) to 3.5% (Okara) (mean = 1.6%) (Table 1).

The proportion of the Indian gerbil (*Tatera indica*) in pellets from the six districts varied from 0.6% (Sheikhupura) to 2.4% (Jhang) and averaged 1.6%. The contribution of the bush rat (*Gollunda ellioti*) to the diet of the Barn

Owl was relatively small. It was represented only in the samples from Faisalabad, Jhang, and Hafizabad with an average proportion of 0.3% (Table 1).

Diversity.—The greatest diversity in the diets of Barn Owls was in Jhang District (Table 2) and differed among Sheikhupura ($t = 4.47$, $df = 4$, $P < 0.05$), Toba Tek Singh ($t = 5.02$, $df = 6$, $P < 0.01$), and Okara ($t = 7.51$, $df = 10$, $P < 0.01$) districts. The diet at Faisalabad was more diverse than in Sheikhupura ($t = 3.11$, $df = 4$, $P < 0.05$) and Toba Tek Singh districts ($t = 4.51$, $df = 2$, $P < 0.05$) (Table 3).

DISCUSSION

Shrews are the preferred prey of the Barn Owl throughout the world (Glue 1974, Lovari et al. 1976, deBruijn 1979, Bose and Guidali 2001, McGhie 2001). Their noisy conflicts and territorial behavior make them vulnerable to predation (Cody 1982, Churchfield 1990). Furthermore, once located they are easier to catch than rats and mice (Fast and Ambrose 1976, Nishimora and Abe 1988, Derting and Cranford 1989). The Barn Owl population in central Punjab, Pakistan exhibited a strong preference for house shrews (*Suncus murinus*). It was the staple food item and was predominant in the diets of Barn Owls inhabiting the agroecosystems of central Punjab, Pakistan.

Wheat-sugarcane, wheat-rice, and wheat-rice-sugarcane are the predominant agroecosystems of central Punjab. Wheat is sown mainly from late October through early December and is harvested from mid-April through early May. Transplantation of rice occurs during June and July and harvesting extends from late September through early November. The cane crop is the most stable habitat for rodents in croplands as it remains much longer than any other crop grown in the area. Cane harvesting starts in October and continues until late spring after which small scattered patches are left in the fields to be used as seed. These stands of cane provide shelter for rats and mice longer than any other crop in the study area. The cover provided by this crop greatly affects prey capture efficiency of Barn Owls (Munoz and Muroa 1990, Duckett 1991) and the owl is not able to exploit the murids in proportion to their abun-

TABLE 1. Relative frequency (%) of prey items in Barn Owl pellet samples from six sites in central Punjab, Pakistan (M = number of pellets, n = number of prey items in M, * unidentified rats).

Prey items	Locality (1-6) and % Relative abundance (n)						Combined M = 2,360
	1 M = 342	2 M = 388	3 M = 1,163	4 M = 394	5 M = 37	6 M = 36	
Shrews	56.3 (271)	75.0 (403)	67.2 (1,085)	59.3 (348)	65.6 (40)	68.4 (39)	65.6 (2,186)
<i>S. murinus</i>	56.1 (270)	75.0 (403)	67.2 (1,085)	59.2 (346)	65.6 (40)	68.4 (39)	65.5 (2,183)
<i>S. etruscus</i>	0.2 (1)			0.3 (2)			0.1 (3)
Squirrel		0.2 (1)	0.1 (2)	0.5 (3)			0.2 (6)
<i>F. pennanti</i>		0.2 (1)	0.1 (2)	0.5 (3)			0.2 (6)
Rats & mice	36.7 (176)	22.0 (118)	27.5 (444)	26.3 (153)	32.8 (20)	28.1 (16)	27.8 (927)
<i>R. rattus</i>	4.4 (21)	1.9 (10)	4.2 (68)	2.6 (15)	1.6 (1)	1.8 (1)	3.5 (116)
<i>R. meltda</i>	5.6 (27)	5.4 (29)	7.3 (117)	3.8 (22)	16.4 (10)	1.8 (1)	6.2 (206)
<i>M. musculus</i>	4.4 (21)	1.3 (7)	2.5 (40)	2.2 (13)	1.6 (1)	5.3 (3)	2.5 (85)
<i>M. booduga</i>	4.8 (23)	4.3 (23)	1.6 (26)	1.4 (8)		3.5 (2)	2.5 (82)
<i>B. bengalensis</i>	9.4 (45)	5.4 (29)	5.6 (90)	7.4 (43)	6.6 (4)	10.5 (6)	6.5 (217)
<i>N. indica</i>	1.2 (6)	1.5 (8)	1.7 (28)	1.4 (8)	3.3 (2)	3.5 (2)	1.6 (54)
<i>T. indica</i>	2.1 (10)	0.6 (3)	1.4 (23)	2.4 (14)	1.6 (1)	1.8 (1)	1.6 (52)
<i>G. ellioti</i>	0.2 (1)		0.1 (1)	1.4 (8)			0.3 (10)
UR*	4.6 (22)	1.7 (9)	3.2 (51)	3.8 (22)	1.6 (1)		3.1 (105)
Bats	1.9 (9)	1.1 (6)	1.8 (29)	3.8 (22)		1.8 (1)	2.0 (67)
Birds	4.8 (23)	1.7 (9)	3.0 (49)	9.9 (58)		1.8 (1)	4.2 (140)
Herptiles	0.3 (2)		0.2 (4)				0.1 (6)
Insects			0.1 (1)		1.6 (1)		0.1 (2)
Totals	481	537	1,614	584	61	57	3,334

1. Hafizabad District.
2. Sheikhpura District.
3. Faisalabad District.
4. Jhang District.
5. Toba Tek Singh District.
6. Okara District.

TABLE 2. Prey diversity in the diet of the Barn Owl in central Punjab, Pakistan.

	Richness (S)	Diversity (H')	Evenness (E)
Hafizabad	14	1.38	0.52
Sheikhupura	12	1.09	0.44
Faisalabad	15	1.36	0.50
Jhang	14	1.59	0.60
Toba Tek Singh	9	1.20	0.55
Okara	10	1.01	0.44

dance in cane dominated agroecosystems of central Punjab. However, after harvesting in wheat-rice based systems, rodents disperse in search of shelter (Beg and Rana 1978; Beg et al. 1981, 1983, 1986; Khan and Beg 1990; Mushtaq-ul-Hassan et al. 1998, 1999) making them vulnerable to Barn Owl predation.

Central Punjab is densely populated by humans. Villages, farm houses, and small clusters of adobe houses are present throughout the study area. The house shrew is at home in and around human settlements in croplands. House mice are also common in human settlements as well as farmlands (Ubaidullah et al. 1989, Khan and Beg 1990, Naz et al. 1997, Mushtaq-ul-Hassan et al. 1998). This is not the case with the house rat which is largely an indoor species in Pakistan. Thus, there is a variety of habitats within the home range of Barn Owls.

Our analysis suggests the Barn Owl does not affect pest rats and mice of agriculture in central Punjab. The Barn Owl has apparently no adverse impact on rodent populations because of (1) multi-cropping, which results in the development of a mosaic system where a variety of crops provide protective cover to rodents for the larger part of the year; and (2) the house shrew is the most common prey.

The abundance of Barn Owls in croplands could be enhanced by installing nest boxes throughout croplands and by providing perches at strategic points in the fields.

ACKNOWLEDGMENTS

This study was jointly financed by Pakistan Science Foundation (P-AU/Bio 238) and the World Wide Fund-Pakistan (50016201). We thank these funding agencies for without their financial support, the extensive fieldwork involved in this study would have not been possible. We also thank C. E. Braun and an anonymous referee for valuable comments on this manuscript.

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TABLE 3. Diversity of Barn Owl prey in the six districts of central Punjab, Pakistan. * = $P < 0.05$, ** = $P < 0.01$.

Hafizabad	Sheikhupura	Faisalabad	Jhang	T. T. Singh ^a	Okara
	NS	NS	NS	NS	NS
	Sheikhupura	S*	S*	NS	NS
		Faisalabad	NS	S**	NS
			Jhang	S**	S**
				T. T. Singh ^a	NS
					Okara

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